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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/758,966
Filing Date: January 16, 2004
Appellant(s): STEWART ET AL.

David Griner
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed January 11, 2008 appealing from the Office action mailed February 28, 2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct in that the amendment after final rejection filed on May 29, 2007 has been entered.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is substantially correct. The changes are as follows:

WITHDRAWN REJECTIONS

The following grounds of rejection are not presented for review on appeal because they have been withdrawn by the examiner: the rejection of claims 21 and 22 as being anticipated by Musil.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

2003/0047691	**MUSIL et al.**	**3-2003**
2004/0151991	**STEWART et al.**	**8-2004**

(9) Grounds of Rejection

The following grounds of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-3, 6-8 and 10-12 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent Application Publication 20030047691 of Musil et al. (hereinafter, Musil).

Musil teaches using a Ga ion beam to remove excess chromium from atop a quartz substrate. Musil teaches that when using a Ga ion beam to etch away material from the surface of a substrate, Ga ions will typically be implanted 20-40 nm into a substrate. Therefore, in an attempt to avoid having Ga ions being implanted into the quartz substrate, Musil teaches switching from a Ga ion beam to an electron beam to remove the last 20-40 nm of chromium. With this much chromium serving as a buffer, "little or no Ga will be implanted into the mask itself". To the extent that Ga ion implantation does occur, by using an electron beam to remove the last 20-40 nm of chromium, Musil would also be removing the implanted gallium ions. As such, Musil teaches repairing opaque defects of a lithography mask by directing an electron beam and XeF_2 toward a region of a quartz substrate into which Ga^+ ions have been implanted (see paragraphs [0047]-[0049]). Musil teaches it is beneficial to use an electron beam because the electron beam will not etch the substrate (abstract), and etching gases can be chosen to provide highly selective etching so that the etching can be stopped before an underlying layer of SiO2 is significantly damaged ([0088]) leaving the substrate substantially unaffected ([0033]).

Regarding the process parameter limitations of claims 10-12, 18 and 19, it is noted that Musil does not explicitly teach these limitation. However, as Musil carries out the same process and obtains results that correspond to the process result limitations of claims 6-8, 21 and 22, it follows that the operational parameters used by Musil would also correspond to the operational parameters used by applicant.

Note the following excerpts:

> **[0017]** Electrons cannot sputter material because the momentum of an electron in a typical electron beam is not sufficient to remove molecules from a surface by momentum transfer. ...

> **[0033]** In accordance with one embodiment of the invention, molecules of an electron beam-activated gaseous compound are adsorbed onto the surface of a mask in an electron beam system. The gaseous compound causes one or more materials on the surface of the mask to be selectively etched in the presence of the electron beam. The selective etching allows the removal of some materials while minimally affecting other materials on the surface of the mask. For example, an opaque absorber material may be etched while the transparency of the substrate is substantially unaffected. Because the etching is purely chemical in nature and does not rely on physical sputtering, it is highly selective and causes none of the repair-induced damage that typically accompanies FIB etching. Unlike FIB mask repair processes, the inventive process does not introduce any foreign atoms into the substrate and so avoids staining.

[0047] In step **508**, the excess material defect is located. In step **510**, an operator typically identifies the defect on monitor **490**, for example, by drawing a polygon around the defect area. The designated area to be scanned is often referred to as a "box." The defect may also be located and identified automatically. Because the electron beam will not damage the quartz substrate, the entire area within the polygon may be scanned by the electron beam. The scan can also be limited to the actual defect area, as determined by the contrast in image intensity between the defect and non-defect area.

[0074] An electron beam system of the present invention can be mounted in the same vacuum chamber as a focused ion beam or can be an independent system. The system can include other accessories, such as other types of surface characterization instruments, including x-ray or Auger electron spectrometers, that can be used to characterize the etch products. Such system can be used to detect when the defect material has been completely removed. In many embodiments, end point detection is not critical because the electron beam will not significantly etch the substrate or will etch the underlying material at significantly slower rate, even in the presence of the etchant gas. The etch process is selective to the opaque material and continuing to direct the electron beam to the substrate in the presence of the gas will not result in overetching or create any flaw in the photolithography mask.

> **[0080]** The different etch rates of different materials allows the electron beam to selective etch different layers. For example, SiO_2 etches relatively slowly compared to metallic or metal-containing compounds, such as Ta, TaN and W, so these materials can be etched and the etch process stopped before an underlying layer of SiO_2 is significantly damaged.

Claims 1-12, 21 and 22 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by US Patent Application Publication 2004/0151991 of Stewart et al.

Stewart incorporates by reference the teachings of Musil. Additionally, Stewart explicitly teaches the electron beam removes implanted Ga ions and "restores transmission". See, for example the following excerpts (with emphasis added):

> [0036] Mask repair can use both electron beam and ion beam etching and deposition. In embodiments in which it is not desired to use ion implantation staining, an electron beam repair is preferred because it eliminates ion implantation. For example, MoSi and TaN.sub.2 absorber material can be etched using an electron beam and an etchant gas, such as XeF_2, as described in **U.S. patent application Ser. No. 10/206,843 for Electron Beam Processing by Musil et al., which is hereby incorporated by reference.** The gallium beam can be also be used for etching chrome, and **the gallium-implanted layer can be removed using the gas assisted etching using the ion beam or an electron beam.**

> [0038] A strategy to repair a particular defect can include multiple stages, using combinations of ion, electron or lasers. For example, **an ion beam can be used to remove an opaque defect and then an electron beam can be used to etch a layer of gallium-implanted quartz using XeF.sub.2 as post processing to restore transmission**.
>
> [0044] In accordance with various repair strategies that can be used, a work piece can be processed using an electron beam or an ion beam. The effects of **ion implantation can be**: 1. avoided by using an electron beam for some operations; 2. used constructively to provide desired optical properties; or 3. **eliminated by removal of the implanted layer.** Multi-stage operations that use a combination of laser beams, ion beams, and electron beams can speed operations and reduce defects. For example, **an ion beam can be used to process a defect and then an electron beam can be used to remove the effects of the ion beam.**

The references applied above have a common inventor with the instant application. Based upon the earlier effective U.S. filing date of these references, they constitute prior art under 35 U.S.C. 102(e). These rejections under 35 U.S.C. 102(e) might have been overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the references was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

(10) Response to Argument

Applicant's argument, see the paragraph bridging pages 14 and 15, filed January 11, 2008, with respect to Musil failing to teach the percentage of transparency being restored has been fully considered and is persuasive. Therefore, the rejection of claims 21 and 22, as being anticipated by Musil has been withdrawn.

Regarding claims 1-3, 6-8 and 10-12, appellant argues that the Musil reference teaches a method of removing an opaque defect, such as a spot of chromium on top of a quartz substrate. Musil teaches using electron beam etching, instead of ion beam etching, so that the defect can be removed without damaging the quartz substrate. Appellant argues Musil does not teach any method at all for restoring or even improving the transmission of a Ga implanted quartz substrate. Appellant argues that gallium implantation is merely a possible by-product of Musil's opaque defect repair process and that Musil does not teach "restoring the transparency of a quartz material having implanted gallium" or "restoring the transparency of a transparent substrate having an implanted material" as required by appellants' claims. Musil only teaches removal of an opaque layer on top of the quartz. Musil says nothing about repairing implantation or restoring the transparency of an implanted layer. Appellant continues with many arguments that are premised upon the notion that the only opaque defect removed by Musil is the chromium defect that overlies the quartz substrate. However, Musil teaches that Ga ion implantation will occur and therefore, Musil teaches the presence of an implanted opaque defect as well (an opaque defect that will be removed by the electron beam processing taught by Musil).

Appellant argues that the examiner misinterprets the plain claim language in that Musil's removal of an opaque defect removes excess chromium overlying a quartz substrate and thereby Musil increases the transparency of the entire photomask but it does not increase the transmission of the quartz material as required by the claims. Appellant argues the claim language specifically addresses the transmission of the quartz layer itself and that removal of an opaque chromium defect overlying a quartz substrate does not affect the transmission of the quartz.

Additionally, appellant argues that Musil teaches directing the electron beam at the overlying defect material, not at the quartz substrate, to which the examiner responds, a beam that is directed at a material would also be directed at the substrate underlying the material.

Applicant argues that claims 4, 5 and 9 are not taught by Musil. The examiner notes that claims 4, 5 and 9 were not rejected over Musil.

Regarding claims 10-12, appellant argues that Musil does not teach using the claimed electron dose of less than 2.0 $nC/\mu m^2$, for example, a dose of between about 0.4 $nC/\mu m^2$ and about 0.8 $nC/\mu m^2$.

The examiner notes that Musil teaches using an electron beam currents of 0.2 A/cm^2 over a 65 μs period which corresponds to the claimed $nC/\mu m^2$ dose of electrons.

Regarding the rejection over Stewart, appellant argues that the Stewart reference fails to teach restoring to 90% the transparency of the quartz material (or substrate) while the thickness of the quartz material is either substantially unchanged or etched by less than 5 nm. Appellant argues that while Stewart does address restoring the

transmission of gallium-implanted quartz layer, the layer is repaired by removing the implanted quartz using electron beam assisted etching which would substantially change the thickness of the layer. Nowhere does Stewart mention increasing the transmission of the implanted quartz material without substantially changing the thickness of the layer or by etching the substrate less than 5 nm.

In response the examiner notes that both Stewart and Musil, which is incorporated by reference into Stewart, teach that the electron beam treatment takes place without etching or damaging the quartz substrate.

(11) Related Proceeding(s) Appendix

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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